US DOE Building Envelope R&D

CSI/LBNL Workshop

December 8, 2008

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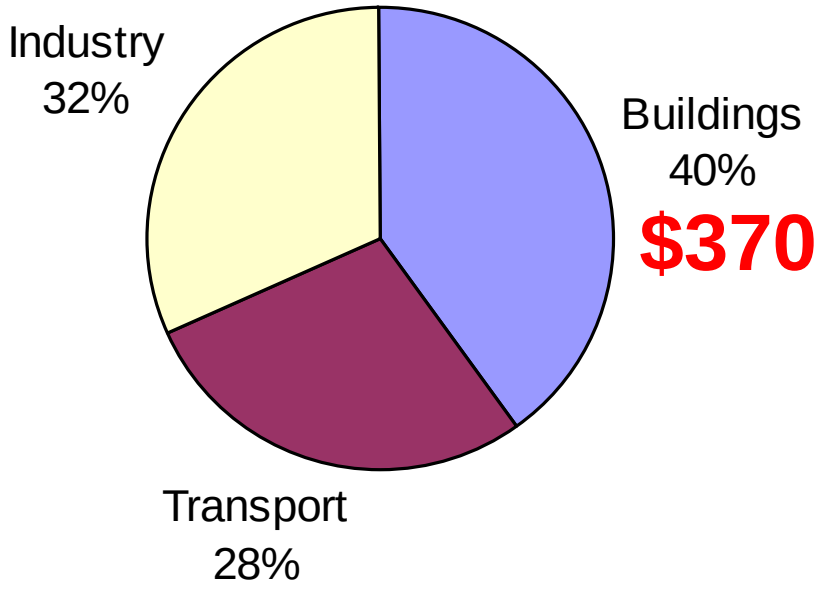
Building Technology Program
Office of Energy Efficiency and Renewable Energy
US Department of Energy

EERE Programs

- Biomass
- **Building Technologies**
- Distributed Energy
- Federal Energy Management Program
- FreedomCAR & Vehicle Technologies
- Geothermal
- Hydrogen, Fuel Cells & Infrastructure
- Industrial Technologies
- Solar Energy Technology
- Weatherization & Intergovernmental
- Wind & Hydropower Technologies

US Energy in Buildings

Electricity – 70% for Buildings



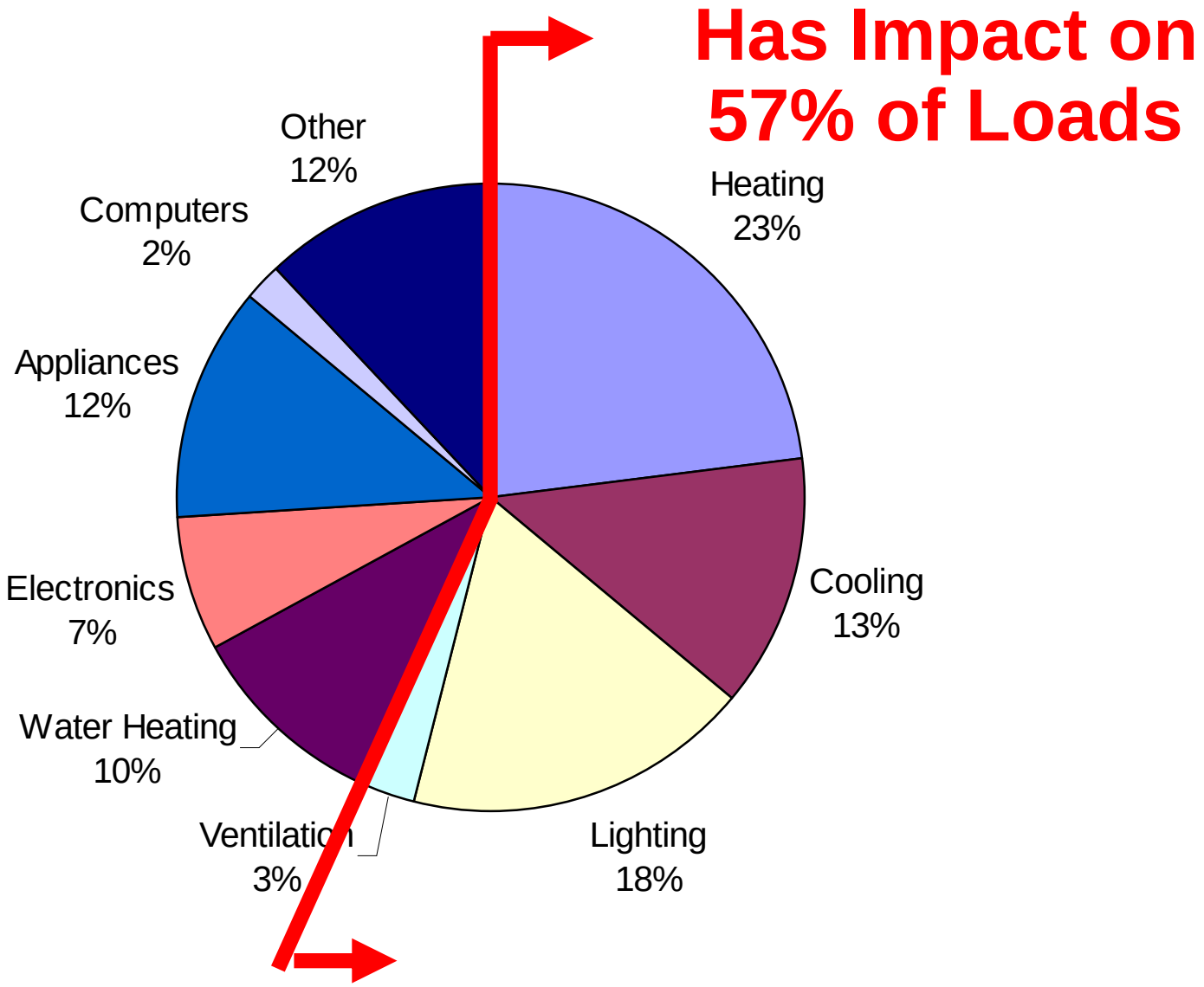
$370 Billion Annually

Total US Building Envelope Energy Loss:

14.1% of Energy in US Economy and about 3.5% of the world.

$133 Billion Annually

Building Consumption – Envelope Relationship



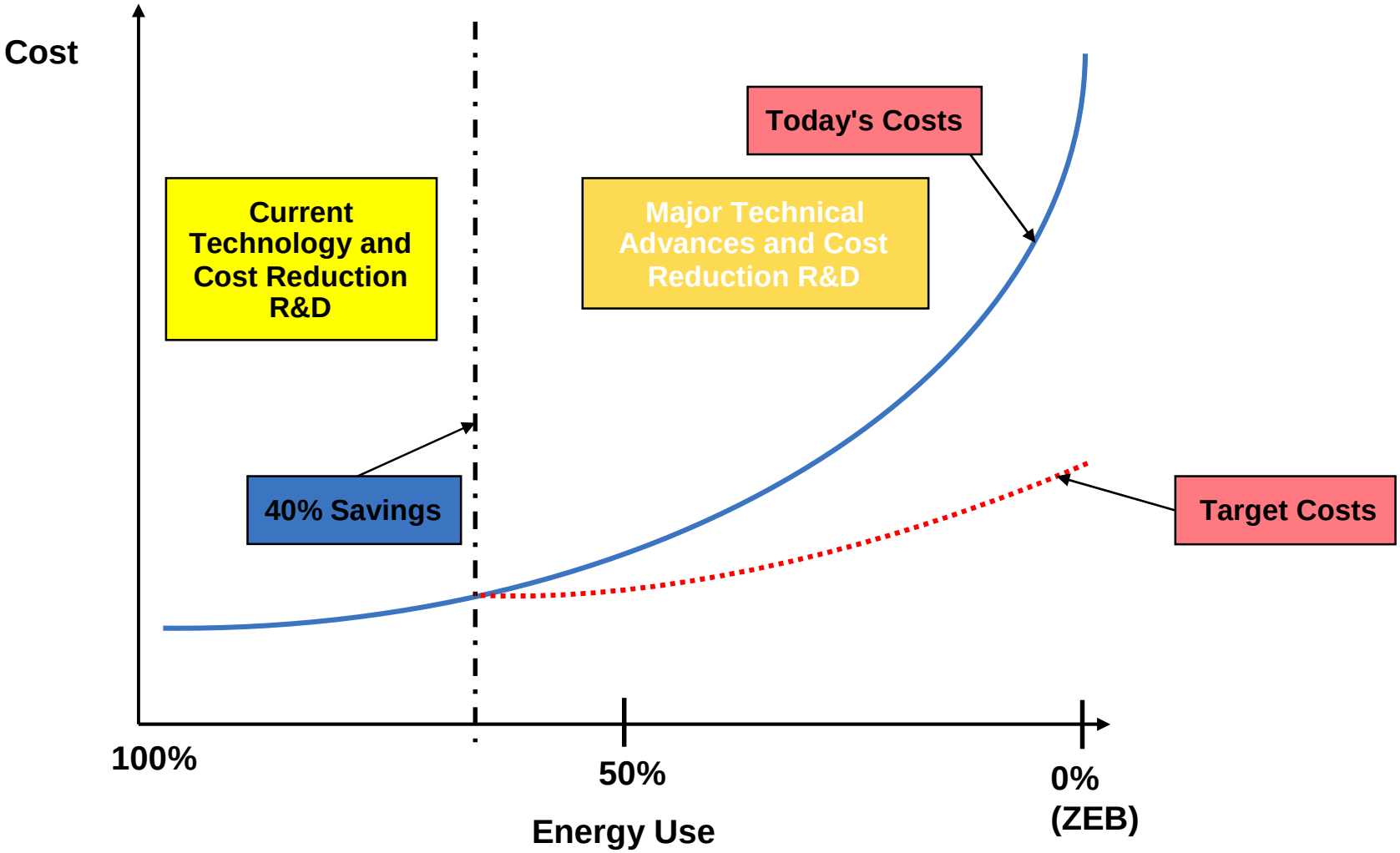
Building Technologies Goal

Net-Zero Energy Buildings by 2025

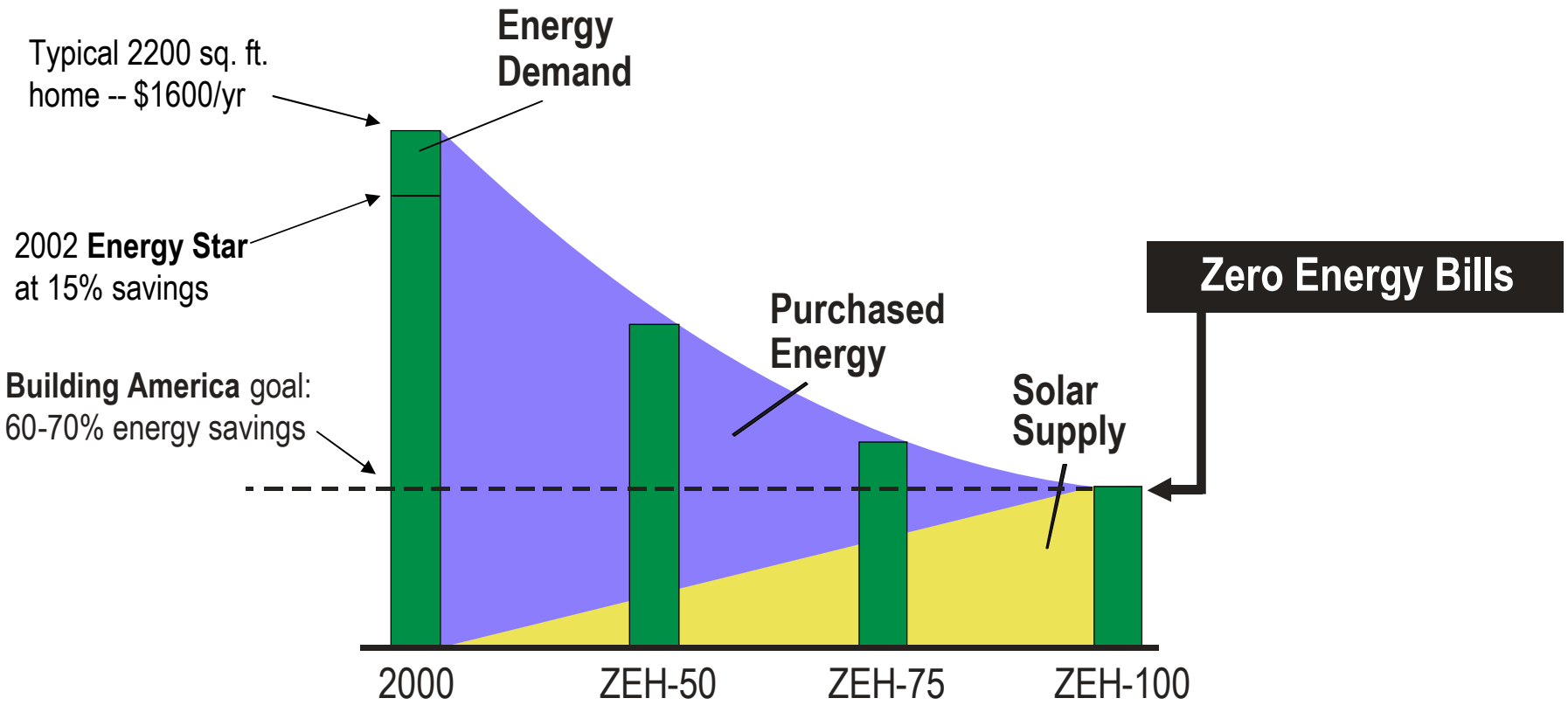
Net-Zero Energy Homes by 2020

Low incremental cost.

Moving to ZEB will require significant technical advances to meet performance and cost targets



Zero Energy Homes



ZEH-100 Saves 100% of Traditional Household Energy Use

DOE Policy on Green Buildings, Sustainability, Embodied Energy, Disposal, etc

Primary focus has to be energy efficiency, and other issues are secondary

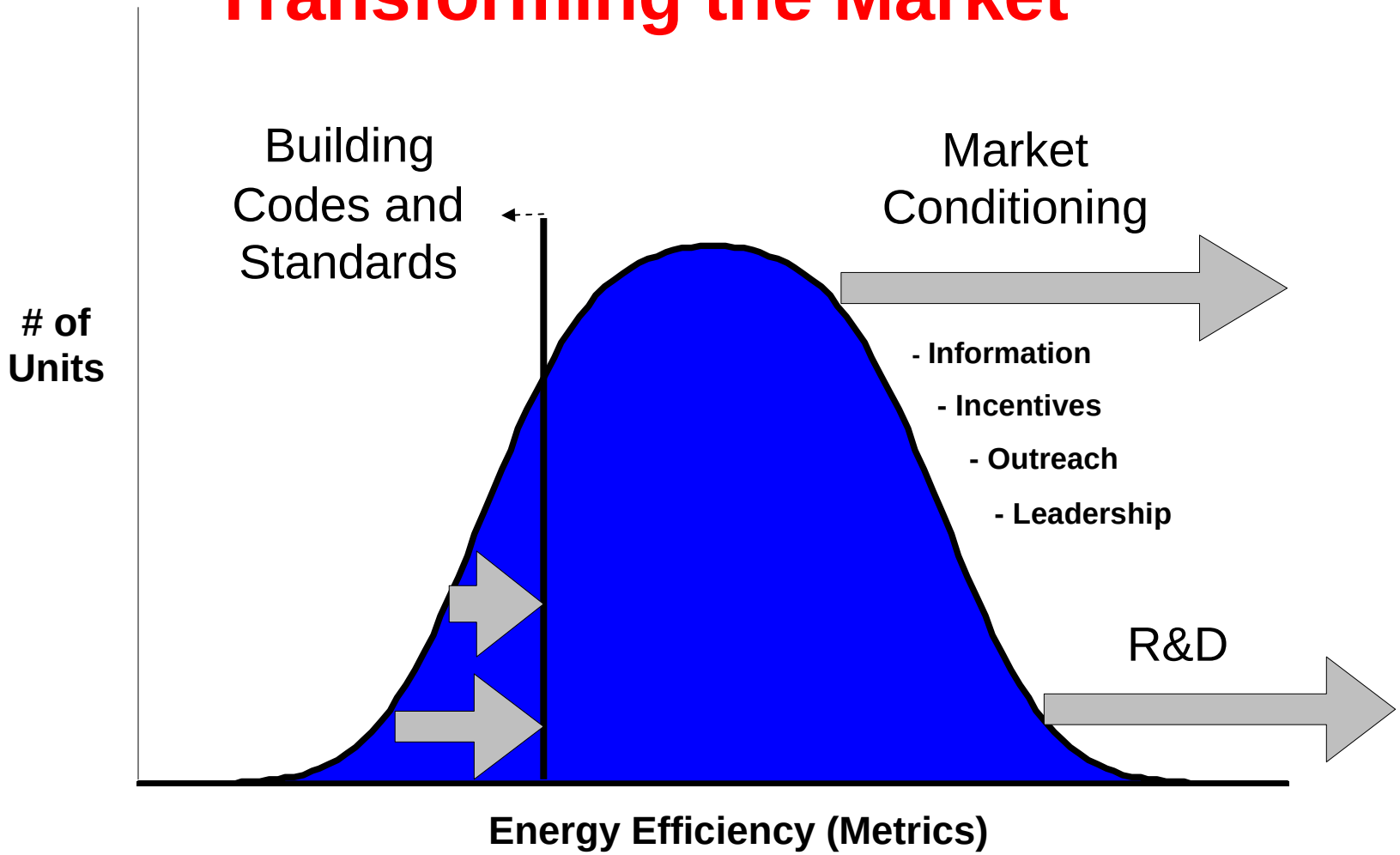
Renewable is essential for ZEB but energy efficiency has highest ROI

Major Areas of Building Technology Program

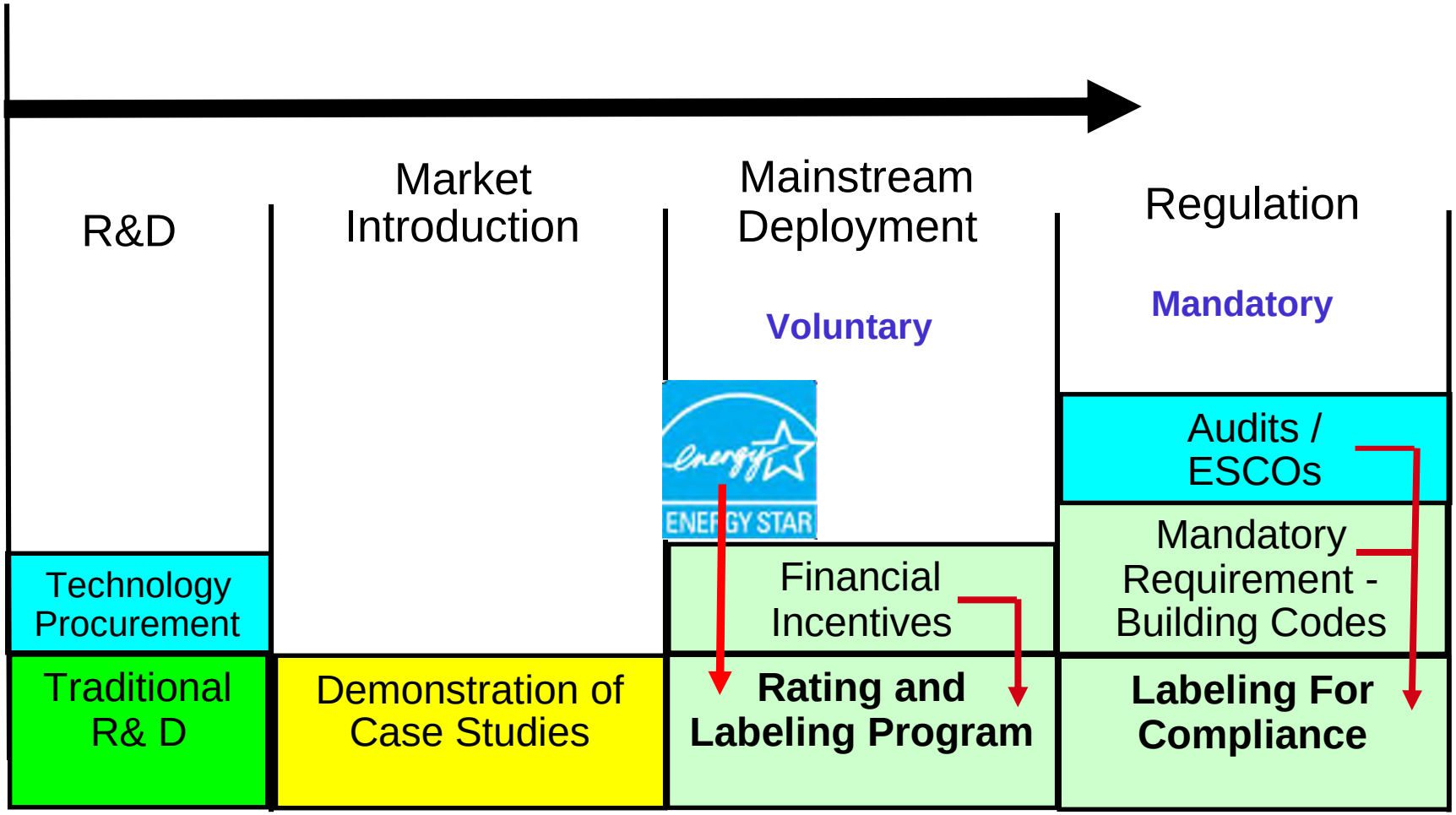
- Emerging Technology (Component R&D)
  - Lighting R&D (Solid State Lighting)
  - Envelope R&D (Windows and Thermal Materials)
  - HVAC and Water Heating R&D
- Residential Integration (Building America)
- Commercial Integration (National Accounts)
  - Retail, Schools, Office Buildings, etc
  - Energy Plus Software
- Technology Validation & Market Introduction
  - ENERGY STAR
  - Building Code Deployment
- Appliance and Equipment Standards

Moving Product Performance Forward with Energy Efficiency Policies

Transforming the Market



Policies – Commercialization Path



U.S. Department of Energy
Energy Efficiency and Renewable Energy

Total Building Envelope and Window R&D Budget

	Administration Budget Request	Enacted Appropriations/ Labor Buying Power	
FY 01	12.3 M	11.5 M	Base
FY 02	4.4 M	11.5 M	
FY03	5.1 M	8.3M	
FY04	5.1M	8.2M	
FY05	5.0M Windows 0 Envelope	5.8M Windows 2.8M Envelope	
FY06	5.0M Windows 0 Envelope	*3.8M Windows (*earmarks) 2.9M Envelope	
FY07	4.7M Windows 2.4M Envelopes	4.7M Windows 2.4M Envelope	
FY08	4.7M Windows 2.4M Envelopes	4.7M Windows 2.4M Envelope	**7.1M <38%** **Labor <54%**
FY09	5.2M Windows 3.4M Envelopes	TBD	

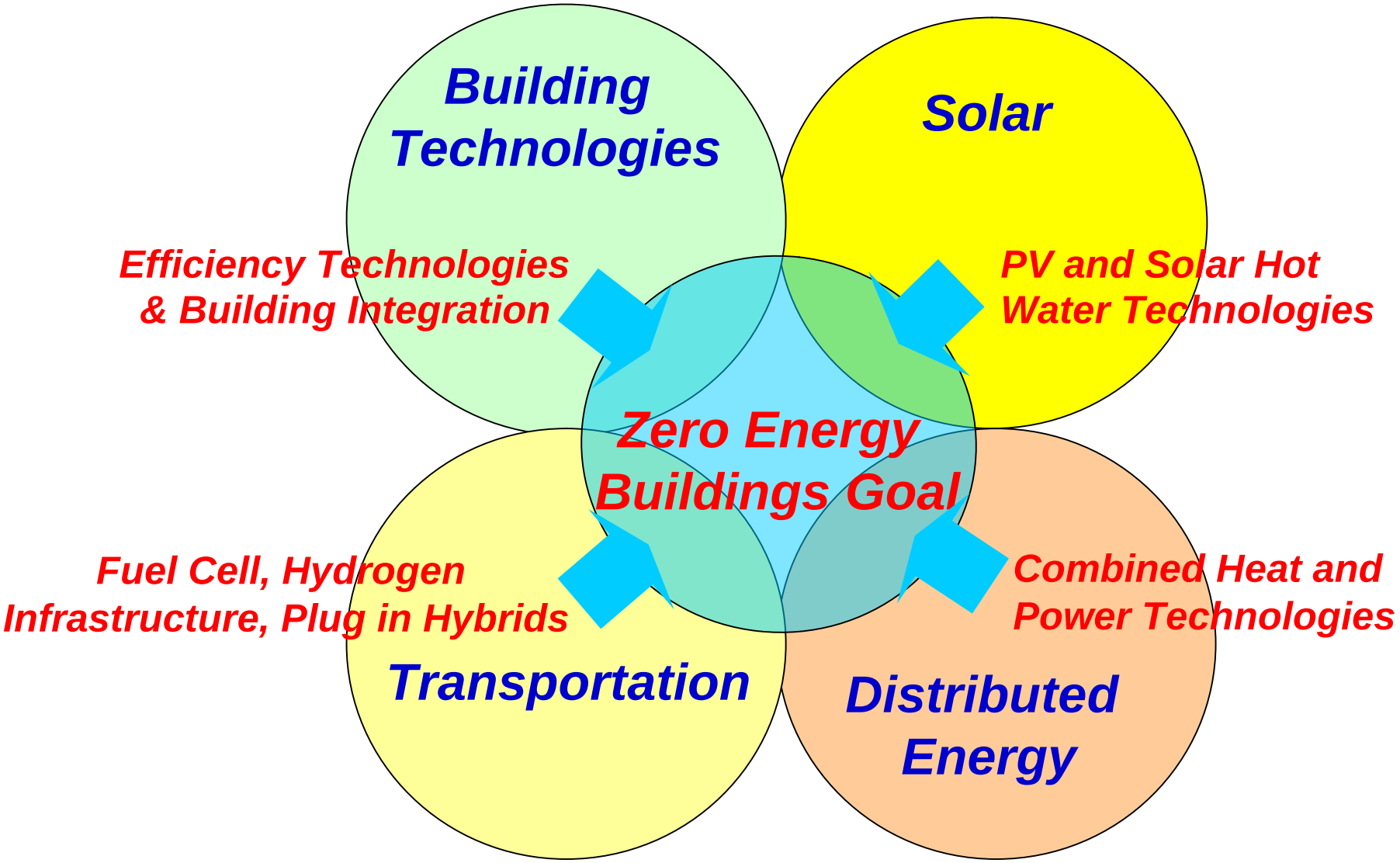
BT FY09 Request 124M

FY09 Appropriations Committee Report

BTP Area	House	Senate
Commercial	+20M	+27M
Solid State Lighting	+5.9M	+10M
Deployment	+13.3M	+9.7M
Standards	+5M	
Residential		+5M
BUILDINGS TOTAL	+44M	+52.7

Buildings as the Integrator

Renewable Energy, Building Technologies, and Transportation become Fully Integrated with ZEBs



Electric/Electric Hybrid Plug-in

Argonne NATIONAL LABORATORY

Building Sector can free up electricity capacity for transportation

Envelope can play a major role in A/C reduction

Natural Gas for Transportation

Saving energy in building envelope can provide natural gas capacity for the transportation sector

Future for Windows and Facades

- Next generation window – highly insulating and dynamic
- Can be net energy gainers in cold and mixed climates
- Integrated commercial façade systems
- PV Solar facades, opaque and transparent

Prototype – Concept Window (Highly Insulating and Dynamic)
U – 0.18 (~ 1.0 SI)
SHGC 0.04 – 0.34
Low cost unsealed center lite

Integrated PV Glazing

Dynamic Window Field Trials – Collaboration with Industry

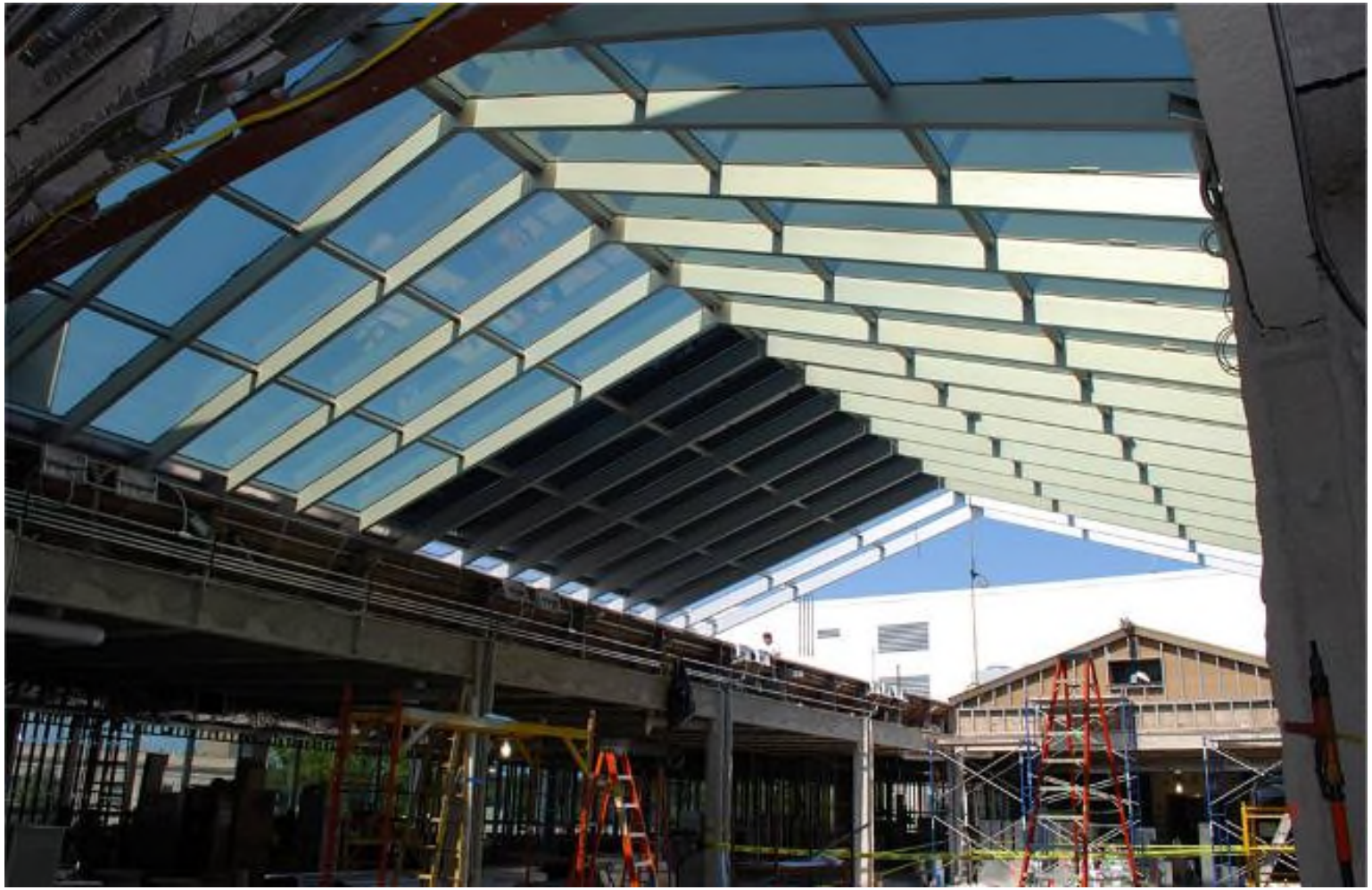
Project Results

- Cooling Energy Savings up to 20%
- Peak Demand Savings up to 26%
- Human factors evaluation

Commercial

Residential

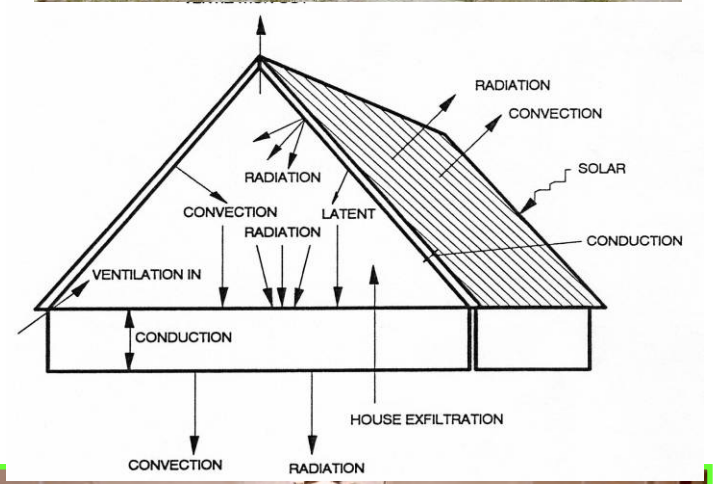
Dynamic Windows – Now Market Ready
Prices will drop with more R&D and investment

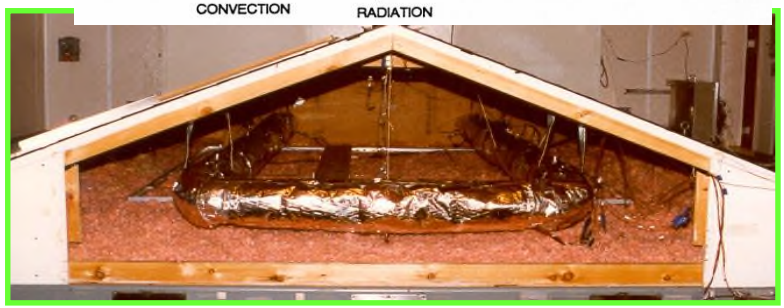


CT, September 2008

Thermal Envelope R&D

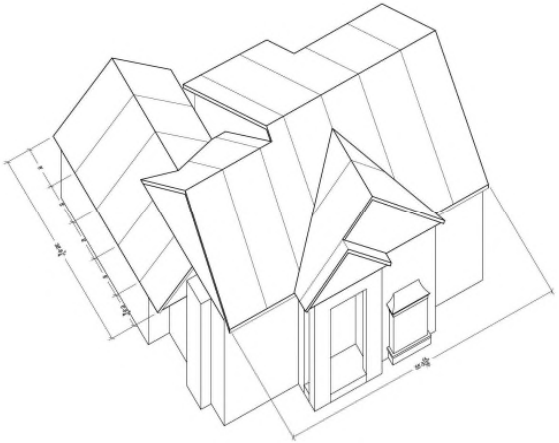
- Advanced walls to reach R 20 in 3.5” cavity, exterior insulation systems, R30 total wall
- Next Generation of Attic/Roof System to save 50 Percent Energy
- New Material Development
  - Phase change insulation
  - Higher performing foams and aerogels
  - Dynamic membranes





Next Generation of Roofing/Attics

- Integrated solutions for building type and climate
- Key elements to develop and integrate
  - Cool Roofs (lighter colors and infrared (IR) Blocking Pigments)
  - Thermal Mass
  - Above Deck Ventilation
  - Radiant Barriers
  - Location and Higher Performing Insulations



Existing Building Stock - Retrofit Applications – Applied Films, EIFS, etc

Conduct Enabling Research

- Test protocols
- Design guidelines
- Modeling tools
- Industry standards
- Education Materials

Enabling Research

Standards Development

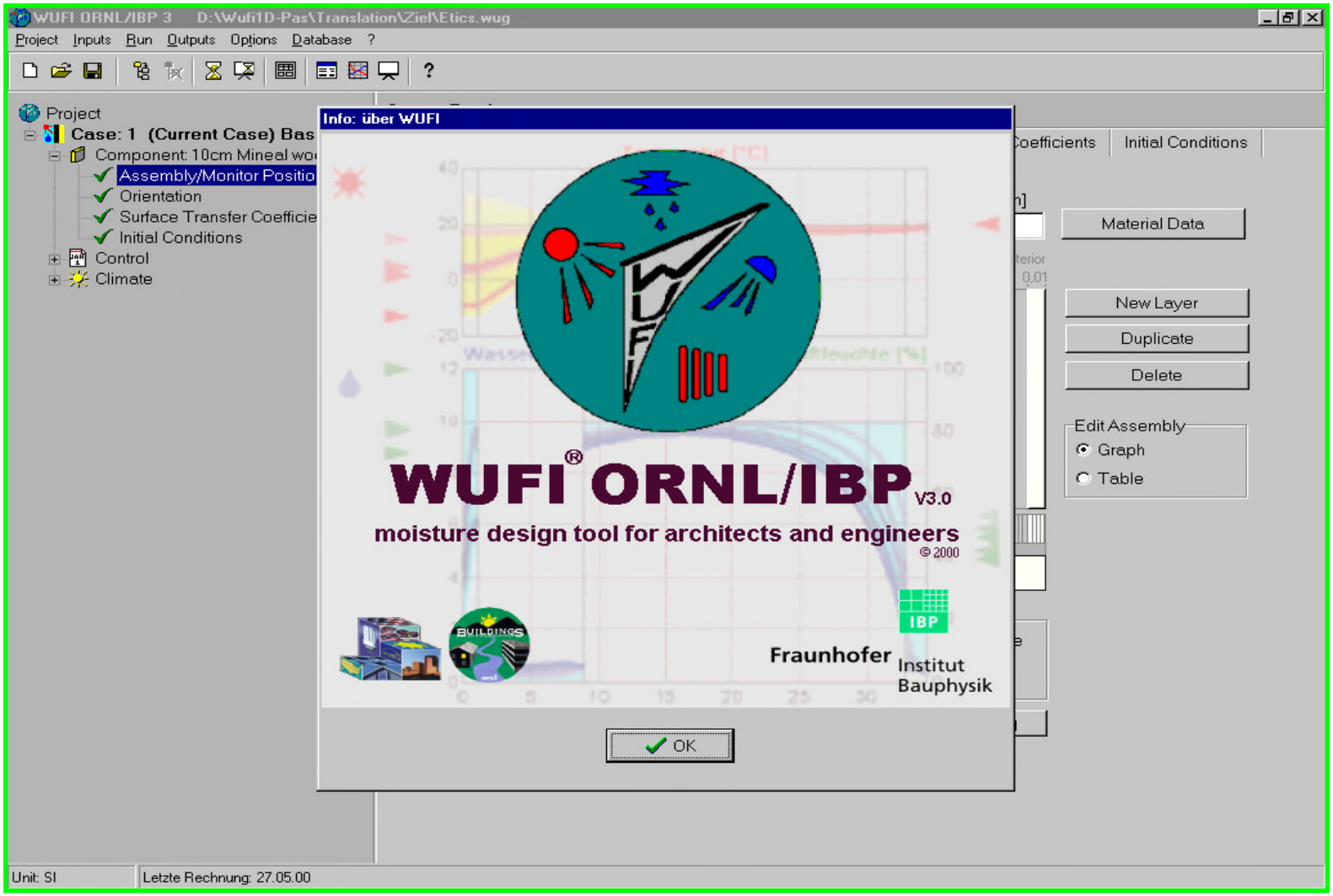
- ASTM
  - C16 on Thermal Insulation
    - Test methods and practices, material specifications
  - E6 on Performance of Buildings
    - Windows, wall systems, roof systems

- ASHRAE
  - Building Materials and Building Envelope Performance (T.C. 4.4)
  - Energy Calculations (T.C. 4.7)
  - Moisture Management (160P) - Design Criteria for Moisture Control
  - Moisture Management in Buildings (T. C. 1.12)

- International Energy Agency
  - Annex 41 on Moisture in Buildings

- International Council for Research and Innovation in Building and Construction
  - CIB W40 Heat and Moisture Transfer in Buildings

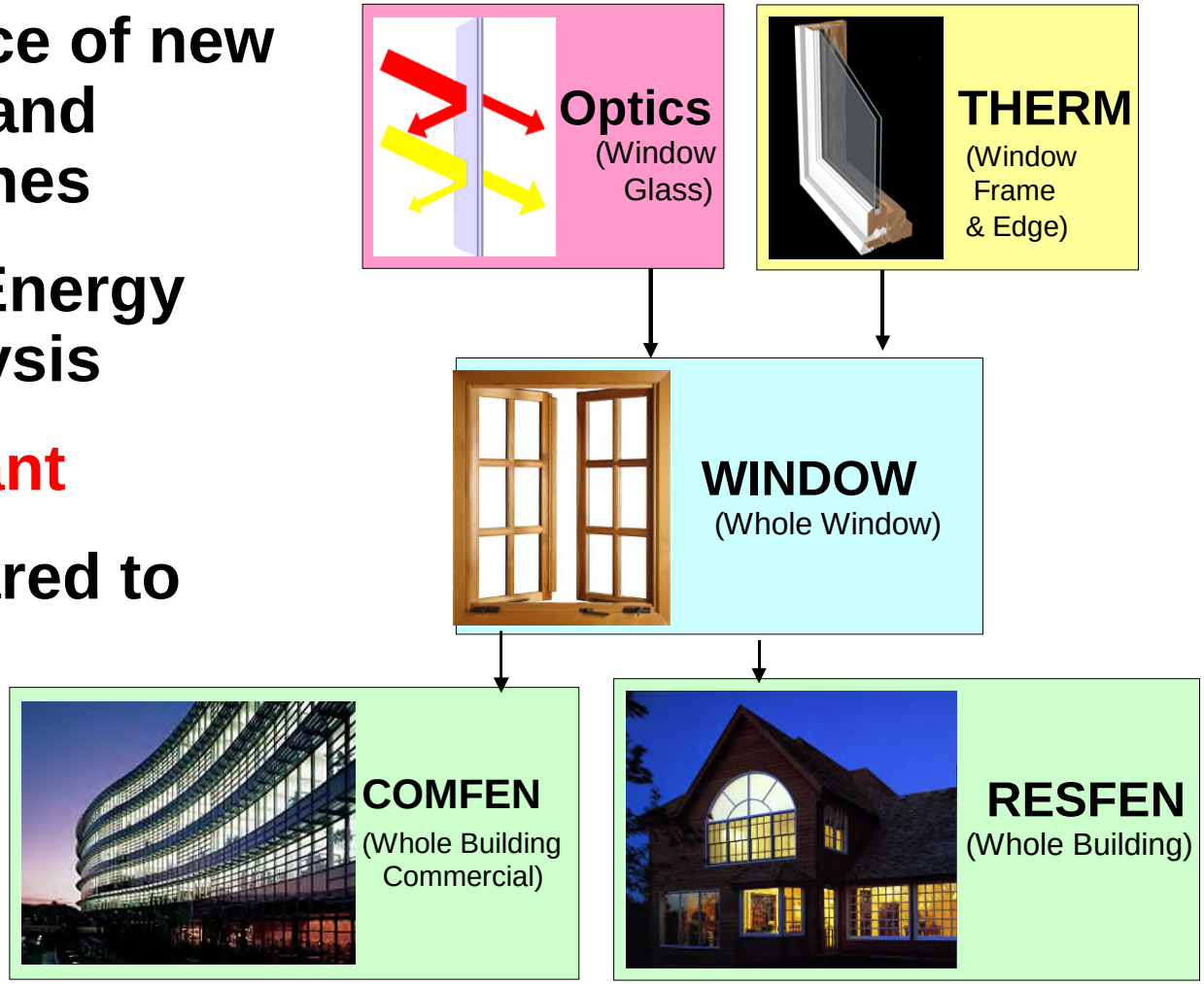
Hygrothermal Model Available



www.ornl.gov/sci/btc/moisture

DOE Software Tools: LBNL team

- **Predict performance of new product concepts and existing product lines**
- **Thermal, Optical, Energy Performance Analysis**
- **ISO 15099 Compliant**
- **Simulation (compared to Testing) is:**
  - **Cheaper**
  - **Faster**
  - **More consistent**
  - **More accurate**



http://windows.lbl.gov

NFRC Ratings

- Software used to calculate properties on NFRC labels (200,000+ products rated)
- NFRC is the basis for policy implemenation
- Currently, about 80 percent of residential windows are rated by NFRC
- Software to simulate performance rather than expensive testing

Voluntary Label: Support ENERGY STAR

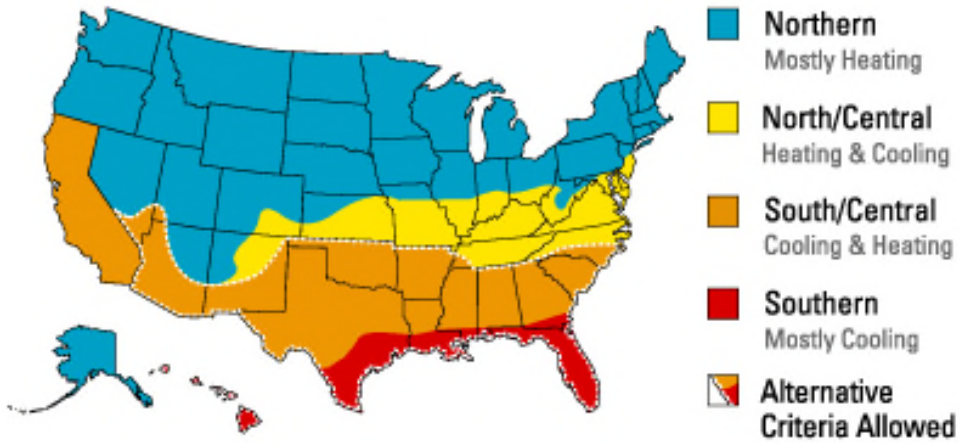
Residential Windows, Doors, and Skylights Key Product Criteria

The ENERGY STAR criteria for residential windows, doors, and skylights are tailored to four Climate Zones. A product's energy efficiency for a given climate is based on its impact on heat gain and loss in cold weather and heat gain in warm weather. Windows that are energy efficient in Florida will not necessarily be energy efficient in Michigan and vice-versa.

Climate Zones for ENERGY STAR Qualification Criteria

The four Climate Zones for ENERGY STAR qualified windows, doors, and skylights are:

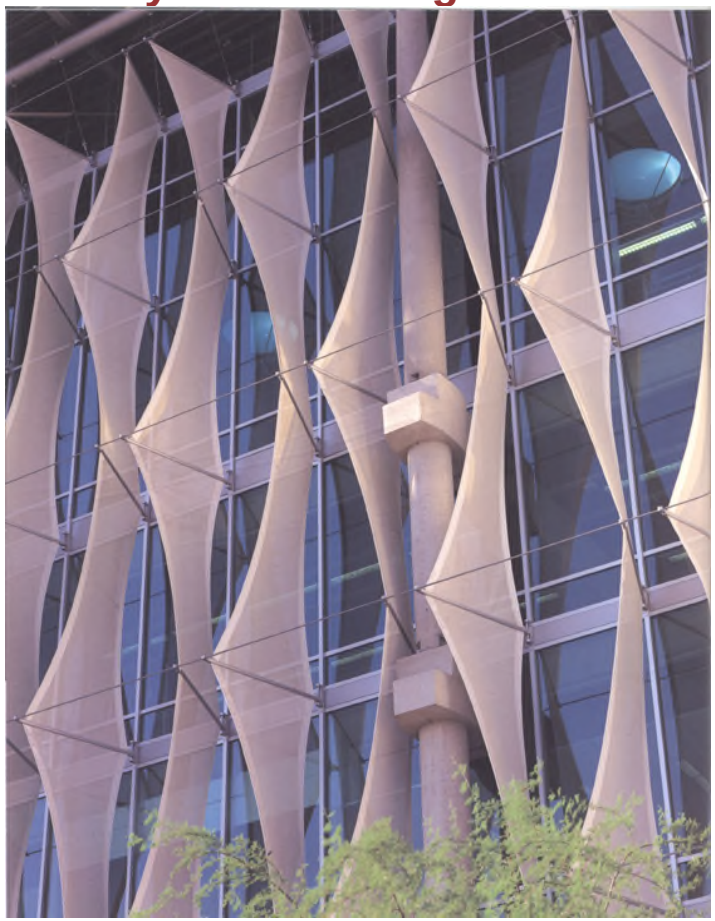
+ Northern: mostly heating
+ North/Central: heating and cooling
+ South/Central: cooling and heating
+ Southern: mostly cooling



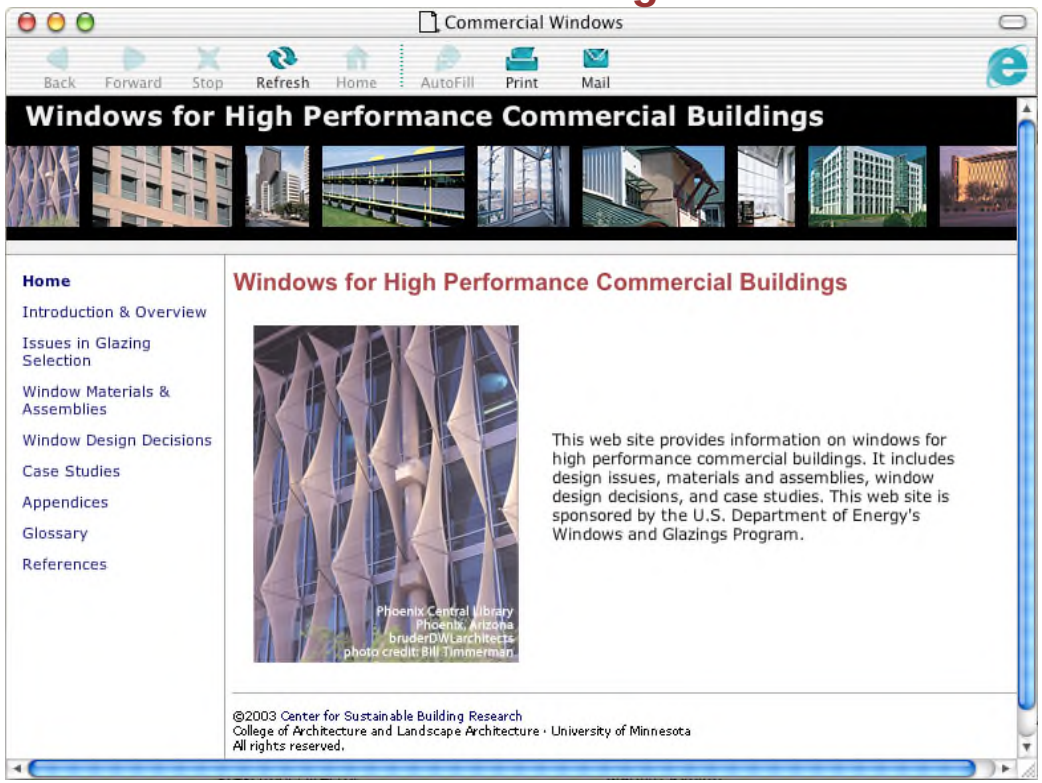
EDUCATION

Tools for Energy Efficient Windows in Commercial Buildings

Handbook for Architects and Engineers: Window Systems for High Performance Buildings

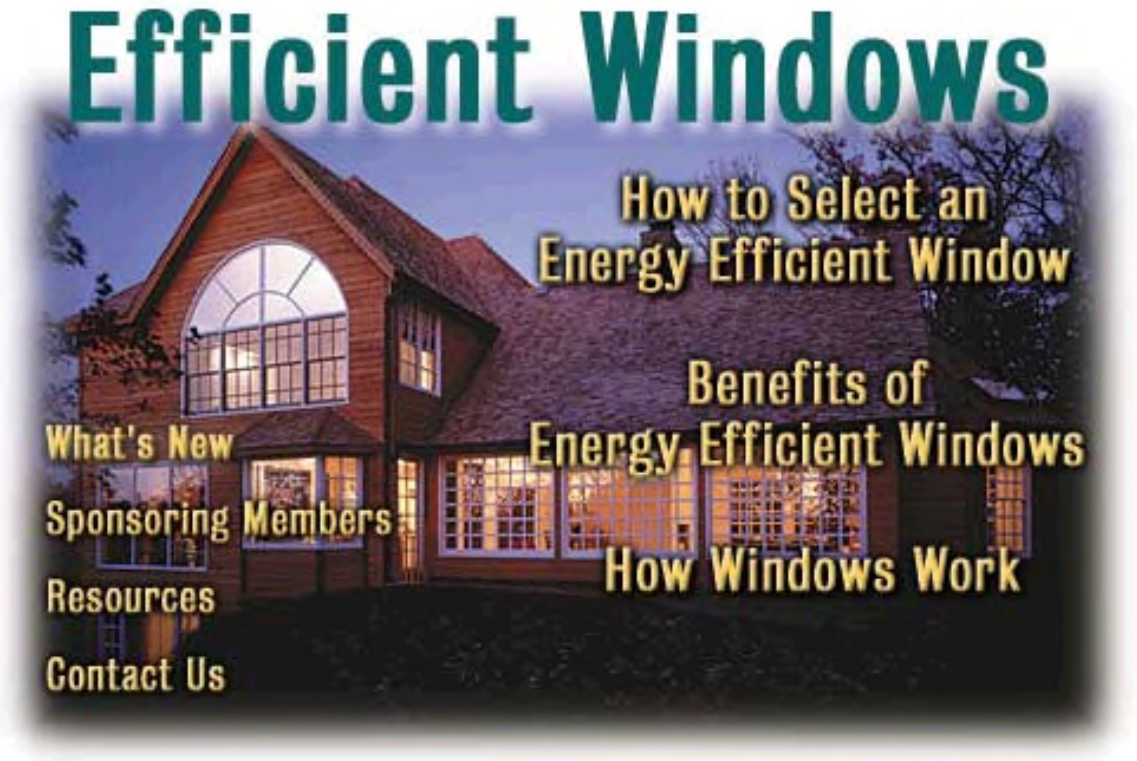


Web Site with Decision Making Tools for Architects and Engineers



http://www.commercialwindows.umn.edu

EDUCATION



Efficient Windows Collaborative

This web site provides unbiased information on the benefits of energy-efficient windows, descriptions of how they work, and recommendations for their selection and use. EWC members have made a commitment to manufacture and promote energy-efficient windows. Take a look to learn more!

The Efficient Windows web site is sponsored by the Efficient Windows Collaborative (EWC) with support from the U.S. Department of Energy's Windows and Glazings Program and the participation of industry members.

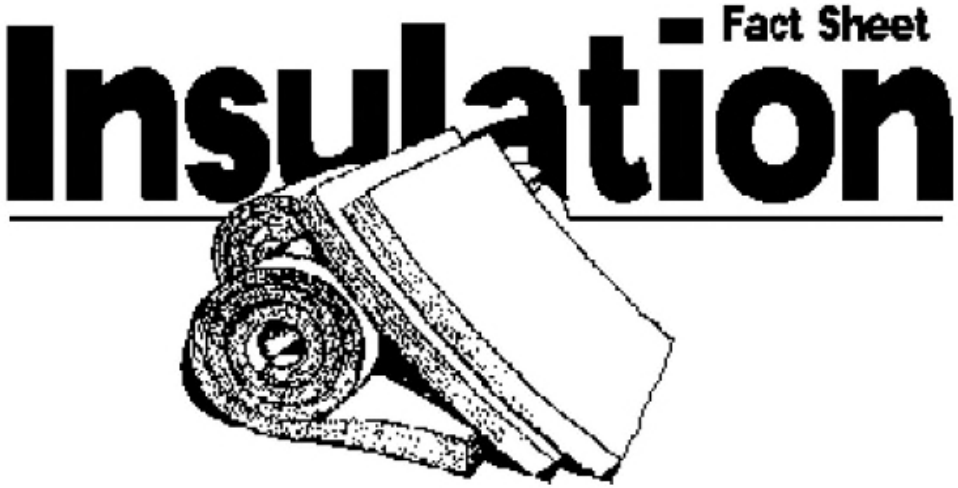
Over 40,000 users per month

www.efficientwindows.org

Consumer/Builder Information

DOE/CE-0180
2008

Department of Energy
Assistant Secretary
Energy Efficiency and
Renewable Energy



Contents:

Introduction

- Why Insulate Your House?
- How Insulation Works

Introduction

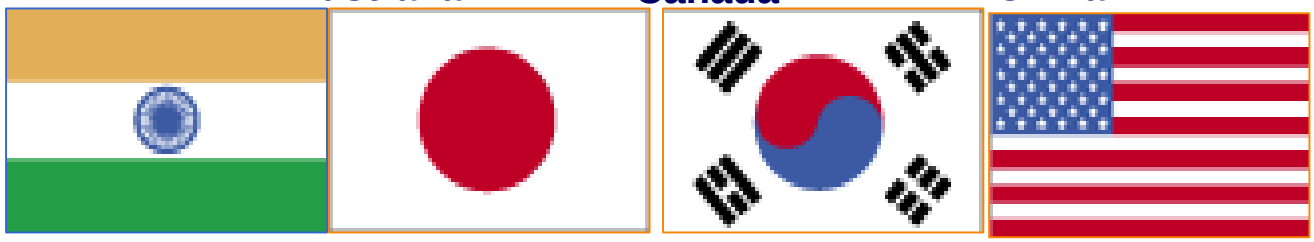
Why Insulate Your House?

Heating and cooling account for 50 to 70% of the energy used in the averag American home. Inadequate insulation and air leakage are leading causes o energy waste in most homes. Insulation:

http://www.ornl.gov/sci/roofs+walls/insulation/ins_01.html

Asia-Pacific Partnership on Clean Development and Climate

Australia Canada China



India Japan Republic of Korea United States

Working with APP countries, ASEAN, and Middle East to support US companies for the sale and investment in manufacturing of efficient envelope products abroad.

Major products being promoted, low e glass, window films, cool roofs, EIFS, insulation, etc.

How DOE works with private industry

- Conducts competitive solicitations for direct funding, 20 percent cost share required
- Formal agreements with National Laboratories, Cooperative Research and Development Agreements (CRADAs), protects existing intellectual property (IP) and manages new IP
- Informal collaboration when IP is not an issue, support through testing, advice, etc - easy to get started
- Case studies and partnerships

Major Areas of Unaddressed Opportunities

- Competitive solicitations for private industry
- R10 windows
- In-depth performance validation and case studies
- Dynamic envelopes
- New Materials
- Daylighting and integrated façade systems
- Product development for products and techniques focused directly on the retrofit market

Key Conclusions

- Envelope can play a major role to achieve ZEB
- Greater industry role in setting priorities needed
- Envelope industry interaction with the Federal government is limited
- Global movement on climate and recent interest in Green construction could accelerate activity

Contact Data

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www.govforums.org/e&w/

http://www.eere.energy.gov/buildings/